MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

EEE3096 – COMMUNICATION ELECTRONICS
(TE, MCE)

17th OCTOBER 2016
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages with 4 Questions only.
2. Attempt **ALL FOUR** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Define the following components in communication electronics:

(i) amplifier, and

(ii) attenuator.

[4 marks]

(b) With the aids of circuit diagram, list out three types of attenuators.

[6 marks]

(c) Design a parallel RLC network with a resonant frequency of 100 MHz, 3 dB bandwidth of 10 MHz and $C = 6$ pF. Assume that all components are ideal.

[7 marks]

(d) Design an impedance matching using L-network for a circuit with source impedance $R_S = 200\ \Omega$ and load impedance, $R_L = 400\ \Omega$, $X_L = 0$ at a frequency of 100 MHz. Sketch and label all the values for each component of the network.

[8 marks]

Question 2

(a) Draw the frequency response for the tuned and untuned amplifier.

[3 marks]

(b) With the aids of suitable diagrams, explain two methods of neutralization.

[2 + 2 marks]

(c) Consider the circuit of Fig. Q2c, given that $r_{ce} = 15\ \text{k}\Omega$, $r_{bb'} = 30\ \Omega$, $r_{b'e} = 1.5\ \text{k}\Omega$, $I_c = 3.8\text{mA}$ and $V_{ce} = 0.5058\ V_{cc}$.

(i) Draw the DC equivalent circuit.

[3 marks]

(ii) Is this a common base, common collector or common emitter configuration? Explain your answer.

[2 marks]

Continued .....

(iii) Perform DC analysis to find R_{b2} and R_e.

[6 marks]

(iv) Draw the small signal equivalent circuit using the hybrid-Π model for the transistor.

[3 marks]

(v) Determine the input resistance looking from the source network and the output resistance looking into the output pin.

[4 marks]

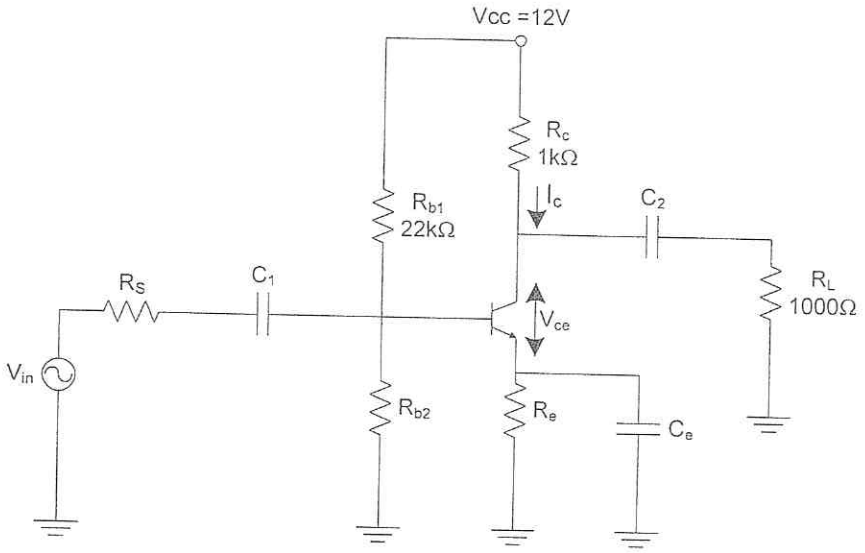

Fig. Q2c

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Question 3

(a) Sketch the block diagram of a Phase lock loop (PLL) and briefly explain the functions for each components of the PLL.

[4 + 8 marks]

(b) The system shown in Fig. Q3b is used to select different channels for a super-heterodyne communication. Determine the following:

(i) f_{ref}

[2 marks]

(ii) N for the receiver to tune to a channel centered at frequency 121 MHz.

[3 marks]

(iii) The resolution (the minimum difference in frequency between two adjacent channels) of the receiver.

[4 marks]

(iv) The loop gain (k_L) of the PLL when tuned to 121MHz.

[2 marks]

(v) Suggest a simple method where loop gain can be fixed while N changes.

[2 marks]

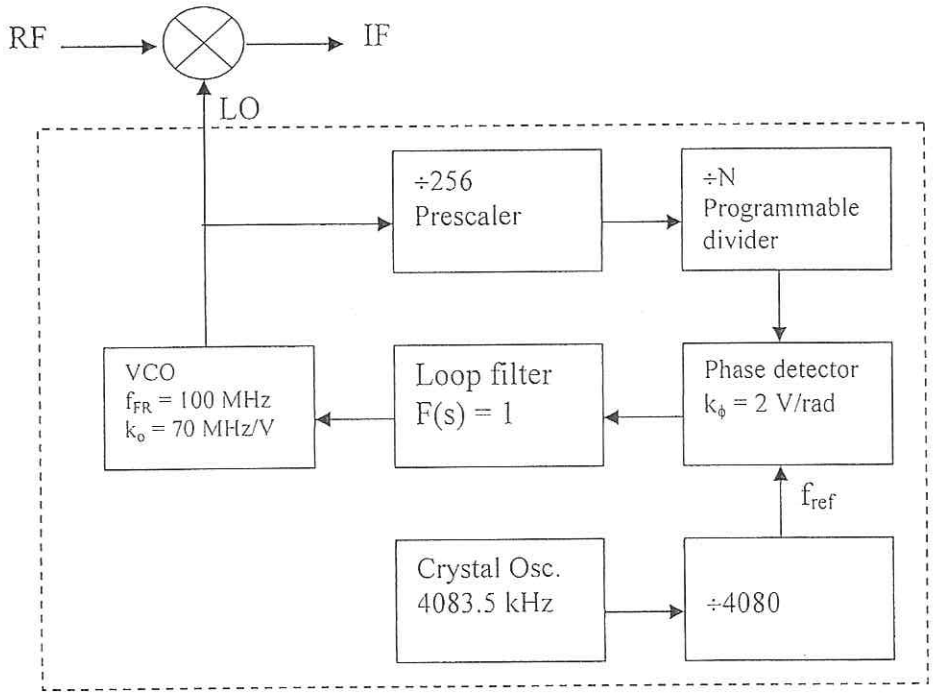

Fig. Q3b

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Question 4

(a) Sketch the block diagram of a black and white television (TV) receiver.

[9 marks]

(b) Explain the basic working principle of gated automatic gain control (AGC). Explain why gated AGC is preferred over AGC using averaging or peak detector in television (TV) receivers.

[6 marks]

(c) Using cathode-ray-tube (CRT) display as an example, describe how contrast control and brightness control can be achieved in television (TV) receiver. Your answer should include the meaning of the terms "contrast" and "brightness", how they are encoded in TV signals, and how they can be controlled or tuned.

[6 marks]

(d) Given that National Television System Committee (NTSC) defines a frame rate of 30 fps with 525 lines per frame. Determine the field and line frequency.

[4 marks]

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Appendix – Useful Formulas

1. L impedance matching network (when $R_L > R_S$):

$$B = \frac{X_L \pm \sqrt{R_L / R_s}\sqrt{R_L^{\,2} + X_L^{\,2} - R_s R_L}}{R_L^{\,2} + X_L^{\,2}} \qquad X = \frac{1}{B} + \frac{X_L R_s}{R_L} - \frac{R_s}{B R_L}$$

$$Q = \frac{|X|}{R_S}$$

2. L impedance matching network (when $R_L < R_S$):

$$B = \pm\frac{\sqrt{(R_s - R_L)/R_L}}{R_s} \qquad X = \pm\sqrt{R_L(R_s - R_L)} - X_L \qquad Q = R_S|B|$$

3. π impedance matching network:

$$L = L_1 + L_2 = \frac{R_l}{\omega_o}\left(\sqrt{R_S / R_l - 1} + \sqrt{R_L / R_l - 1}\right)$$

$$C_1 = \frac{1}{\omega_o R_S}\sqrt{\frac{R_S}{R_l} - 1} \qquad C_2 = \frac{1}{\omega_o R_L}\sqrt{\frac{R_L}{R_l} - 1} \qquad Q = \sqrt{\frac{R_S}{R_l} - 1} + \sqrt{\frac{R_L}{R_l} - 1}$$

4. RF Class A transistor amplifier (Hybrid π model of BJT)

$r_{bb'}$	**The base-spreading resistance.**
g_m	**The transconductance.** $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C(\text{in mA})}{25.875mV}$ at T=300K, q= electronic charge, $1.6\text{x}10^{-19}$C
C_e	**The emitter capacitance.**
$r_{b'e}$	**The input resistance.** $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$
$r_{b'c}$	**The collector to base resistance.** $r_{b'c} = h_{fe} r_{ce}$
C_C	**The collector capacitance.**
r_{ce}	**The output resistance.** $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where V_A is known as the Early voltage and I_C is the dc collector current.

Continued .....

5. High frequency Class A amplifier parameters:

(a) Voltage gain:

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \dfrac{r_{bb'} r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} << r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\omega C_T r_{bb'}}$$

(b) Effective voltage gain (including the effect of source impedance R_S):

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \dfrac{(R_S + r_{bb'}) r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_s + r_{bb'}) << r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\omega C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and C_M = Miller capacitance $C_M = (1 + g_m R_o) C_C$

(c) Transition frequency

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

(d) Input impedance

$$Z_I = r_{bb'} + \frac{r_{b'e}}{1 + j\omega r_{b'e} C_T}$$

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